JASSA

Journal of Applied Science in Southern Africa
The Journal of the University of Zimbabwe

Volume 7 • Number 1 • 2001 **ISSN 1019–7788**

CONTENTS

JASSA

Journal of Applied Science in Southern Africa
The Journal of the University of Zimbabwe

Vol. 7 No. 1 • 2001
ISSN 1019–7788

CONTENTS

Published by University of Zimbabwe Publications
P.O. Box MP203, Mount Pleasant, Harare, Zimbabwe

Typeset by University of Zimbabwe Publications
Printed by MG Printers

A survey of the distribution of and consumer preference for dried fruits and vegetables in the Harare-Chitungwiza metropolis

E. Manzungu and R. Machiridza

Soil Science and Agricultural Engineering Department, Faculty of Agriculture, University of Zimbabwe, P. O. Box MP 167, Mount Pleasant, Harare, Zimbabwe

The distribution of and consumer preference for dried fruits and vegetables in the Harare–Chitungwiza metropolis was studied by conducting two surveys. Data was collected over eight weeks between December 1999 and February 2000. The survey on the distribution of dried fruits and vegetables was conducted in 47 retail shops located in low, medium-and high density areas and the Central Business District (CBD). Low density areas are generally inhabited by high income earners (at least US$909 to Z$50 000 per month) while medium income earners inhabit medium density areas (earning between US$182 and US$909 to Z$10 000 and Z$50 000). The high density areas are home to low income earners earning at most US$182 (Z$10 000). The objective of the survey was to determine the types and brands of dried fruits and vegetables on the market, their source, and to draw a comparison between the prices of fresh and dried products. The products on the market were found to be predominantly from Zimbabwe and South Africa. The distribution of products was found to be related to the socio-economic status of the hinterland serviced by a particular shop. Low density area shops had more total products (both fresh and dry) than the shops in other residential areas. Shops in the low density areas and the CBD had equal ratios of fresh and dried products suggesting that they were patronised by the same type of clients. Medium density area shops had 16 times more fresh than dried products while shops in the high density areas had no dried products at all. On a weight basis dried products were found to be more expensive than fresh products. Price ratios for dried to fresh products ranged from four-fold for apples (*Malus domestica* Borkh.) to 20 fold for mangoes (*Mangifera indica* L.). The survey on consumer preference for dried products was conducted by administering samples of dried fruits; mangoes, apples, peaches (*Prunus persica* L. Batsch) and pears (*Pyrus communis* L.) and questionnaires to a total of 120 individuals in the Harare–Chitungwiza metropolis. The survey was aimed at determining the favourite brand of product for each fruit as well as the attribute considered to be the most important by the consumers, in influencing their preference for the products among colour, texture, taste, shape, size and smell. Optimal Scaling Procedures

were used to analyse the data. For all fruits colour was considered to be the most important attribute followed by taste and smell, respectively. Size and texture were considered of less importance in influencing consumer preference.

Keywords: Dried fruits and vegetables, distribution, consumer preference, attributes, processing.

Introduction

Food processing can be defined as the application of scientific principles to preserve or modify foods so as to make them safe, appealing and of uniform quality (Fellows, 1997a). One method of food processing that is as old as mankind is drying. Drying is the removal of water from products for preservation by making conditions unfavourable for microbial growth (Dauthy, 1995). It can be achieved by soaking products in concentrated sugar or salt solution and then exposing them to open air. This is called air-drying. Products can also be sun, solar or electrically dried. Drying adds value to agricultural produce by extending shelf-life and reducing weight and bulk, thereby making transport cheaper and storage easier (Fellows, 1997a). In Zimbabwe fruit and vegetable drying is attracting the attention of both small-scale and large-scale processors.

Generally, information on large-scale processors in the country is limited because of the desire to maintain confidentiality (FRESCA, personal communication). Some of the large-scale processors include such companies as FRESCA, Nestlé and Cairns. The latter two are mainly involved in secondary processing of dried products. Another example is Lever Brothers which imports dried tomatoes from South Africa to process the Royco range of soups (ZIC, 1997).

Small-scale fruit and vegetable drying in Zimbabwe is said to be potentially profitable (MSFPTD, 1994). Its origins can be traced to the Food Processing as a Small Business (FPSB) Unit of Ranche House College (RHC), an adult education training institute in Harare, the capital city of Zimbabwe. RHC co-operated with the Maastricht School of Management and Facet B.V. in the Netherlands to conceive the Micro/Small-Scale Food Processing Project. The focus of the project was on training, particularly of rural women, to take up small-scale food processing as a business enterprise (MSFPTD, 1994). The focus of the MSFPTD project coincided with the national goal of making agro-based food processing an instrument of growth and development in rural areas thereby creating employment and ensuring food security (GOZ, 1995).

The technology that is employed in small-scale fruit and vegetable drying is suited to rural-based small-scale processors who have limited financial resources at their disposal. Drying is carried out in a solar dryer made up of transparent plastic covering a wooden frame. The wooden frame has two shelves, each supporting three movable trays on which the fresh products are laid out to dry. The dryer uses cheap solar energy making the technology suitable for rural areas.

Another advantage is that drying does not require stringent hygiene conditions such as is the case with juice extraction and fruit canning.

Despite its simplicity, small-scale fruit and vegetable drying in Zimbabwe has been reported to be facing problems. Solar drying technology produces low volumes of poor quality products (Manzungu *et al.*, 2000). The low quantities, around 120 kg per season, do not match the volumes required (one ton) by potential bulk buyers such as Lever Brothers, Cairns, Nutresco, Nestlé and wholesalers and hotels (Sibanda, 1996). Inadequate capital and operating finance, and marketing also pose problems.

Materials and Methods

The study was conducted over eight weeks between December 1999 and February 2000 in the Harare-Chitungwiza metropolis, which has a combined population of about two million (Matorofa, Central Statistical Office, personal communication). Harare is Zimbabwe's largest urban complex while Chitungwiza is the third largest after Bulawayo. Two surveys were carried out to find out the distribution of and consumer preference for dried fruits and vegetables in the study area.

The first survey sought to determine the different types and brands of dried fruits and vegetables on the market, their countries of origin and to draw a comparison between the unit prices of dried and fresh products. The second survey sought to find out what potential consumers thought about the products on the market in terms of which attributes, among colour, texture, taste, shape, size and smell, they considered most important. This was in recognition of the fact that the individual buyer can be an alternative potential market for dried products since the quantities involved are likely to match small-scale production.

Survey 1

Four enumerators visited retail shops situated at major shopping centres located in suburban areas of different socio-economic backgrounds known locally as low, medium and high density areas. Table 1 gives the definitions of the residential areas from two perspectives, on a plot size basis (City of Harare's Physical Planning Division) and income earned basis (Consumer Council of Zimbabwe). The size of the stand reflects socio-economic status — the bigger the residential stand the higher the economic resources of the owner thereof. Grocery supermarkets and shops in the CBD were also surveyed. The first step in the survey was to identify shops that stocked fresh and dried fruits and vegetables in the different residential areas. In all, 47 shops were identified as shown in Table 2. These constituted the sample population for the survey. Data collected included the different types and brands of fruits and vegetables, the nature of the products (fresh or dry) and the prices of the products. The countries of origin were also noted.

The Statistical Package for Social Sciences (SPSS) version 8.0 for Windows was used to analyse the data.

Table 1: Definitions of surveyed category areas.

Area	Size of residential stand	Socio-economic status
Low density	>1000 m^2	High income (>US$909)
Medium density	300–1000 m^2	Middle income (between US$182 and US$909)
High density	150–300 m^2	Low income (<US$182)
CBD	N/A	Mixed

Table 2: Names of the surveyed shops.

Low density	Medium density	High density	CBD
Clicks (Sam Levy's)*	Greencroft Provisions	OK (Kuwadzana)	Kensington
Bon Marché (Sam Levy's)	TM (Greencroft)	Lucky 7 (Kuwadzana)	Lucullus (5^{ave})
Clicks (Newlands)	OK (Greencroft)	OK (Mbare)	Athienitis (5^{ave})
Clicks (Chisipite)	OK (Marlbereign)	Mutomba (Mbare)	Classique (5^{ave})
TM (Kamfinsa)	Plaza Greens (Malbereign)	Mutomba (Machipisa)	TM (Down town)
Farmer's Market (Westgate)	OK (Marimba)	OK (Machipisa)	Montague
TM (Westgate)	Spar (Marimba)	TM (Machipisa)	TM (Rezende St)
TM (Avondale)	OK (Parktown)	Spar (Highglen)	Clicks (Angwa Building)
Bon Marché (Avondale)	OK (Queensdale)	TM (Highglen)	Batanai
Rokos (Avondale)	TM (Arcadia)	Mutomba (Highglen)	
TM (Sam Levy's)	Spar (Hatfield)	OK (Chitungwiza)	
TM (Borrowdale)		TM (Chitungwiza)	
		Jema (Highglen)	
		Machipisaimu	

* Brackets denote the name of the shopping centre

Survey 2

Fruits for the survey were purchased from shops in the Harare-Chitungwiza metropolis. Table 3 gives relevant details about the samples (for reasons of confidentiality the table does not give the names of the manufacturers). All the fruits were treated with preservatives such as sodium metabisulphite except for three brands from Zimbabwe (Table 3). Information on consumer preference was obtained by means of a questionnaire. Respondents, chosen randomly from the study area, were asked to score the different brands on a sliding scale of one to five

representing very good and very bad, respectively. There was a provision for respondents to make remarks on issues they felt had not been addressed by the questionnaire. Four enumerators administered the questionnaires, one for each fruit. The questionnaire was administered to a total of 30 respondents for each fruit, giving a total of 120 respondents.

Table 3: Details of the sample fruits.

Type of fruit	Survey identification number	Preservative	Country of origin
Apple	1	Present	South Africa
	2	Absent	Zimbabwe
	3	Present	South Africa
Mango	1	Present	Zimbabwe
	2	Absent	Zimbabwe
	3	Present	Zimbabwe
Peach	1	Present	South Africa
	2	Present	Zimbabwe
	3	Absent	Zimbabwe
	4	Present	South Africa
	5	Present	Zimbabwe
Pear	1	Present	South Africa
	2	Present	Zimbabwe

The data was analysed using SPSS version 8.0 for Windows. Analysis of variance (ANOVA), often used to study the effects of factor variables on continuous response variables, was not used as the data was not from a normal population. Instead Optimal Scaling Procedures, developed to transform discrete data into a form which allows categorical data to be analysed using procedures analogous to those used to analyse continuous data, were used.

Results

Survey 1

Range of fruits and vegetables

The main fruits on the market included dried and fresh apples (*Malus domestica* Borkh), peaches (*Prunus persica* L. Batsch), pears (*Pyrus communis* L.), mangoes (*Mangifera indica* L.) and pineapples (*Ananas comosus* [L] Merrill). Other fruits on the market included dried apricots (*Prunus armeniaca* L.), plums and prunes (*Prunus prunophora* L.), grapes and raisins (*Vitis vinifera* L.), fresh bananas (*Musa acuminata* Colla.), avocado pears (*Persea americana* Mill.) and oranges (*Citrus sinensis* L.). Tomatoes (*Lycopersicon esculentum* Mill.), cabbages (*Brassica oleracea* var. *capitata* L.) and rape (*Brassica napus* L.) were the dried vegetables on the market. Fresh vegetables on the market included brocolli (*Brassica oleracea* var. *italica* L.), onions (*Allium cepa* L.), carrots (*Daucus carota* L.), cabbages, chillies (*Capsicum annuum* L.),

cowpeas (*Vigna unguiculata* L.), cauliflower (*Brassica oleracea* var. *botrytis* L.), garlic (*Allium sativum* L.), and potatoes (*Solanum tuberosum* L.) and some traditional vegetables such as *Cleome gynandra* or *Gynandra gynandra* and pumpkin leaves (*Curcubita sp.* L.).

The dried and fresh fruit and vegetable products were mainly from Zimbabwe and South Africa. Zimbabwe has such products as fresh cabbages, tomatoes, onions, cauliflower, plums, apples, pineapples, pears, mangoes and peaches. Dried products from Zimbabwe included mangoes, apricots, prunes, pears, tomatoes and leafy vegetables. Out of a total of 1 616 observations (where observation refers to the number of times the product was observed on the market, not the number of products or packets of the product), Zimbabwean products accounted for 86.6 percent while South Africa accounted for 10.9 percent. South African products were mainly dried pears, peaches, apples, apricots and prunes. The origin of the remainder (2.5 percent) of the observations, mainly dried fruits, was unknown. Zimbabwe had twice as many fruits as vegetables on the market and about seven times more fresh than dried products. Of the products from Zimbabwe, there were about 50 times more fresh than dried vegetables and about five times more fresh than dried fruits. Ninety nine percent of the products from South Africa were fruits, with dried products accounting for 97 percent of the total products. Ninety eight percent of the total fruits were dried.

The dried vegetables common on the market were the leafy vegetables (rape and cabbages), tomatoes and onions, which represented a small proportion of the vegetables actually produced and consumed in the country.

Distribution of products in residential areas

Of the total 1 616 observations made, low, medium and high density area shops accounted for 38.5 percent, 22.1 percent and 31.6 percent, respectively. Shops in the CBD accounted for eight percent of the observations. Table 4 gives the ratios between products in the different residential areas. Low density areas had the highest quantities of dried products (75 percent) followed by the CBD (19 percent) and the medium-density areas respectively (six percent). While the low density areas and the CBD had approximately equal quantities of dried and fresh products, the medium density areas had about 16 times more fresh than dried products. High density area shops did not have dried products at all.

Table 4: Ratios of products in the different residential areas.

	Ratios			
	Low density	Medium density	High density	CBD
Fruits:vegetables	3:1	2:1	2:1	3:1
Dried:fresh products	1:1	1:16	—	1:1
Dried:fresh fruits	1:1	1:12	—	2:1
Dried:fresh vegetables	1:12	1:99	—	—

The different brands of dried products and their distribution on the market are shown in Table 5 as well as their countries of origin. The brand refers to the trade name of the product or in some cases the producer (where the brand name and producer are not distinguished). Zimbabwe had more brands of dried products than South Africa. Although Zimbabwe had more brands than South Africa, the two countries had approximately equal quantities of dried products on the market because Zimbabwe had fewer dried products per producer (or brand). The brand 'Safari' from South Africa had about 160 observations on the market while the brand with the highest quantity from Zimbabwe (Nature's Choice) had 85 observations.

Table 5: Countries of origin and distribution on the market of available brands of dried products.

Brand	Country of origin			Distribution (number of observations)		
	ZIM	SA	Unknown	LD	MD	HD
DDFA		✔		10		
Bondana	✔			15		10
Crafty Cottage	✔			14		25
Fantaise	✔			13		
Mt Carmel	✔			6		
Nature's Choice	✔			82	3	
Safari		✔		86	17	54
Innscor	✔			1		
Golden	✔			1		
Dried			✔	21	1	3
Molly			✔	1		
Charons		✔		2		

ZIM – Zimbabwe SA – South Africa DDFA – Dried fruit for Africa
LD – Low density MD – Medium density HD – High density

The products from 'Safari' were found in shops in the low and medium density areas and the CBD. The brand 'Dried', whose origin is unknown, also had products in the three residential areas. From Zimbabwe, Bondana, Crafty Cottage and Nature's Choice, were found in two of the residential areas that stocked dried products. The low density area shops stocked the greatest number of brands of dried products on the market.

Data revealed that products in the same chain shop were stocked differently across residential areas. There were more dried products in the low density areas and CBD shops, followed by the medium density area shops with high density area shops having no dried products. An example is of the TM supermarkets where in one low density area 36 observations of dried products were made with no observations for most high density area shops.

Prices of products

Dried products fetched more than fresh products on the market. Data revealed that for apples the dried product costs about four times more than the fresh product per unit weight. For mangoes dried products cost about 20 times more than the fresh products per kilogram of produce. Table 6 gives the comparisons of the prices of the different dried and fresh fruits

Table 6: Comparison of the prices ($/kg) of the fresh and dried products per unit weight

	Apples	Mangoes	Peaches	Pears	Pineapples
Dry	376	442	250	291	400
Fresh	54	23	66	53	26
Ratio	7:1	19:1	4:1	6:1	15:1

Survey 2

Out of the 13 brands that were in the sample eight were from Zimbabwe and the remaining 5 from South Africa (Table 3).

Apples

A total of three brands were compared, two from South Africa and one from Zimbabwe.

Approximately 90 percent of the respondents preferred brand one from South Africa. Brands two and three each attracted the same rating of approximately five percent. Figure 1 shows the median ratings of the six attributes for each brand. The median rating, and not the mean, was preferred since the data was not continuous.

Figure 1 shows that brand one scored highest for all attributes which explains why it was the most favoured. Respondents were impressed by the colour, texture and taste although they complained about the taste, which they indicated, resembled a fermented product. The texture of the product was said to give the impression of freshness although this was reported to result in a sticky product. Some respondents complained about the varying sizes of the slices. This was perceived to reduce the appeal of the product.

The attributes for brand two, which was produced in Zimbabwe, were all ranked average. Brand two was reported to be too dry, to lack uniformity in colour and to be unappealing because of the presence of a shriveled outer skin. The lack of appeal was more pronounced because of seeds that had not been removed from the product.

Brand three was negatively affected by its colour, which made the product unattractive because of its rusty appearance. It also had a sour taste which was equated to that of a fermented product. The texture of brand three was the best among all its attributes, while the other attributes ranked the same as for brand two.

Colour was the attribute respondents considered to be the most important as it gave the first impression to the consumer. This was followed by taste, shape and smell, respectively. Some attributes were not considered to be of much importance, for example size and texture.

Mangoes

All brands that were surveyed originated from Zimbabwe. Brand two was produced by a group of smallholder farmers, while large-scale commercial farmers produced brands one and three. Brand one was the favourite with approximately 67 percent of the respondents preferring it to the other brands. Brand three came

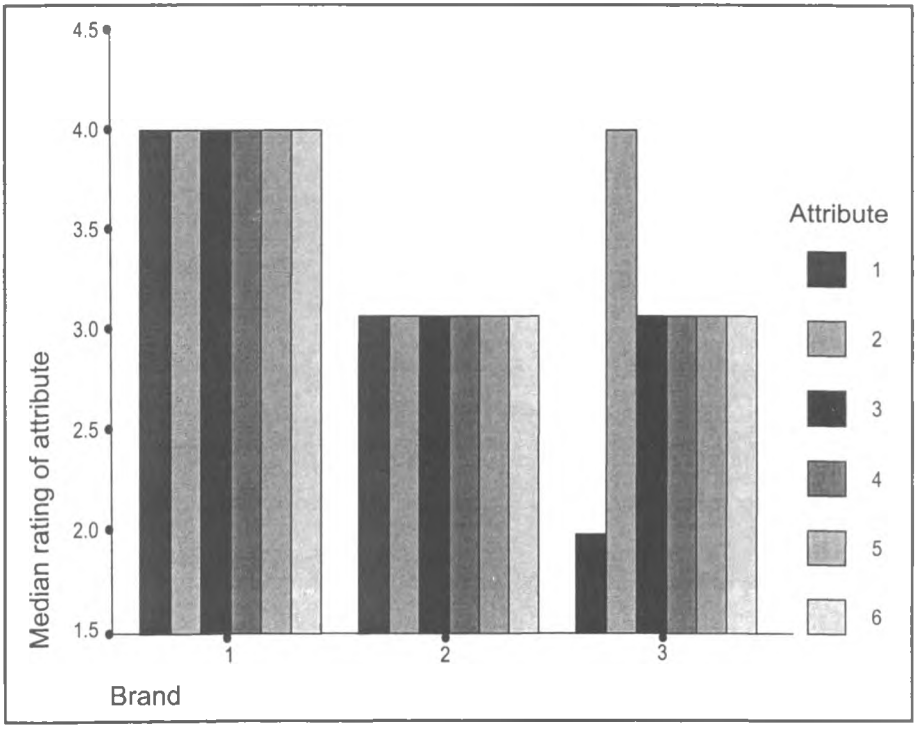

Figure 1: Median rating of each attribute by brand.

Attribute	Rating
1 – colour	1 — very bad
2 – texture	2 — bad
3 – taste	3 — average
4 – shape	4 — good
5 – size	5 — very good
6 – smell	

second with approximately 20 percent of the counts. Brand two received approximately 13 percent of the counts making it the least preferred brand.

Figure 2 shows the median ratings of the various attributes for each brand. Brand one was good all round except for smell which the respondents felt had been masked by the smell of the preservative in the product. The majority of the respondents indicated that the brand was too sweet and that the slices were too big and lacked consistency in size. However the shape was said to be consistent. One opinion was that the colour and shape of brand one looked like tobacco leaves. Some respondents were of the opinion that the product looked like fresh chips, which according to the respondents, was not desirable.

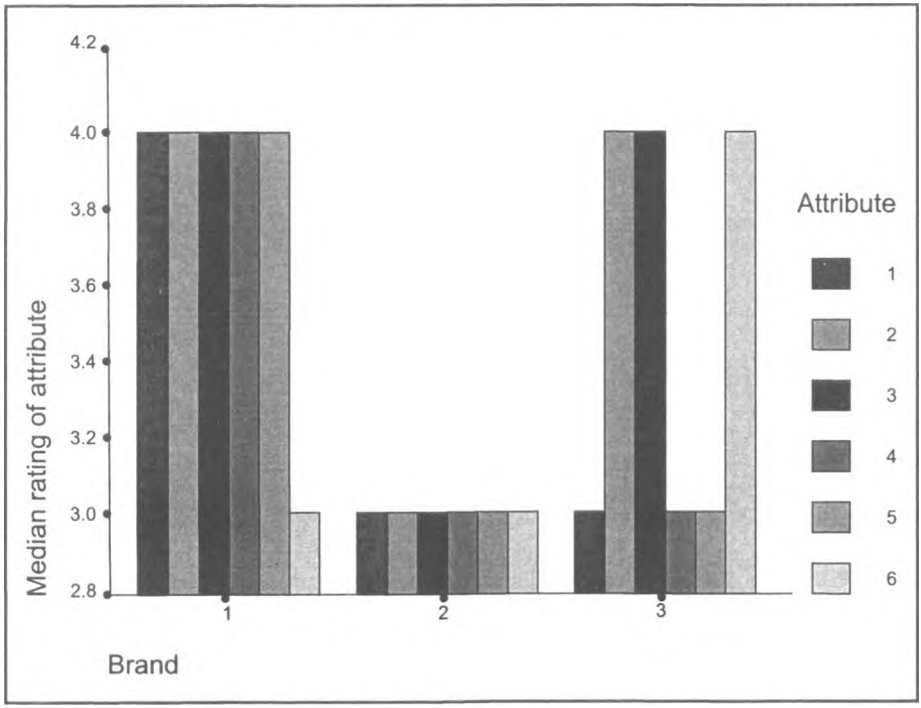

Figure 2: Median rating of each attribute by brand.

Attribute	Rating
1 – colour	1 — very bad
2 – texture	2 — bad
3 – taste	3 — average
4 – shape	4 — good
5 – size	5 — very good
6 – smell	

Brand two was said to exhibit some bitterness. There was a general feeling that the slices of brand two were too thin, too fibrous, too dry and too small to the extent that one was not sure whether one was eating a mango or not. Some respondents felt the size was good in that it was consistent. Some of the slices were described as bright and appealing. However, a few of the slices were reported to have an unappealing brown colour.

Slices of brand 3 were reported to be too big and too sweet by some respondents. Respondents were also of the opinion that the size and shape of brand three were inconsistent. Brands one and three were said to have a fine texture as they were soft

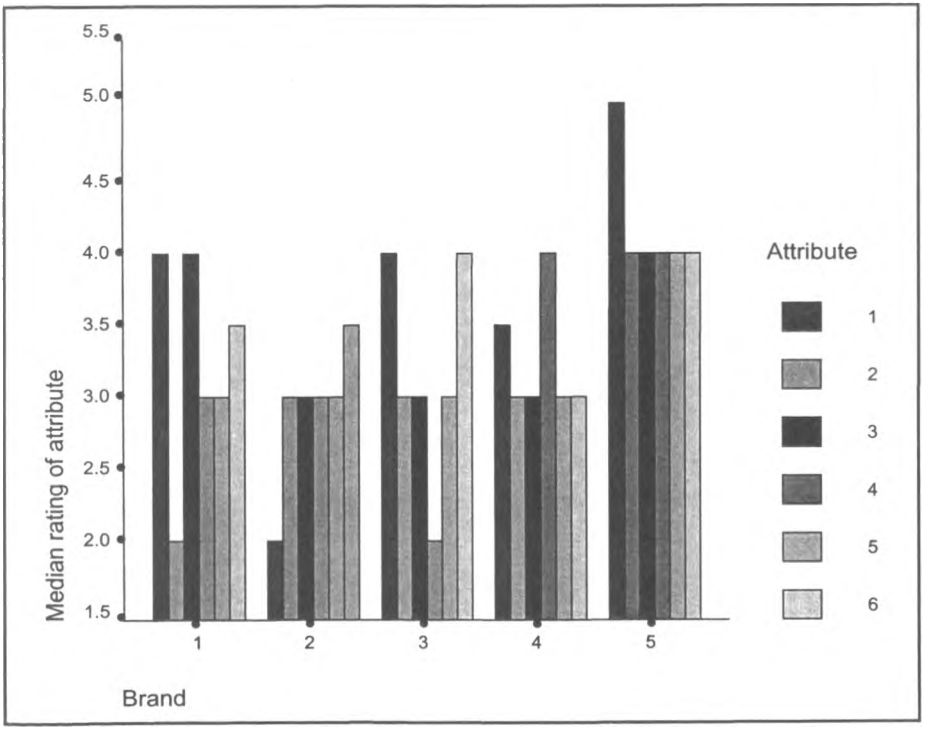

Figure 3: Median rating of each attribute by brand.

Attribute	Rating
1 – colour	1 — very bad
2 – texture	2 — bad
3 – taste	3 — average
4 – shape	4 — good
5 – size	5 — very good
6 – smell	

to bite and chew. Colour was the most important attribute that influenced consumer preference. This was followed by taste, texture and smell, respectively.

Peaches

Five brands were surveyed, three from South Africa and two from Zimbabwe. Brand five, from Zimbabwe, was the favourite with approximately 57 percent of the respondents preferring it. This was followed by brand one from South Africa, which had approximately 17 percent of the respondents selecting it as their favourite. Brand three from Zimbabwe had approximately 13 percent of the

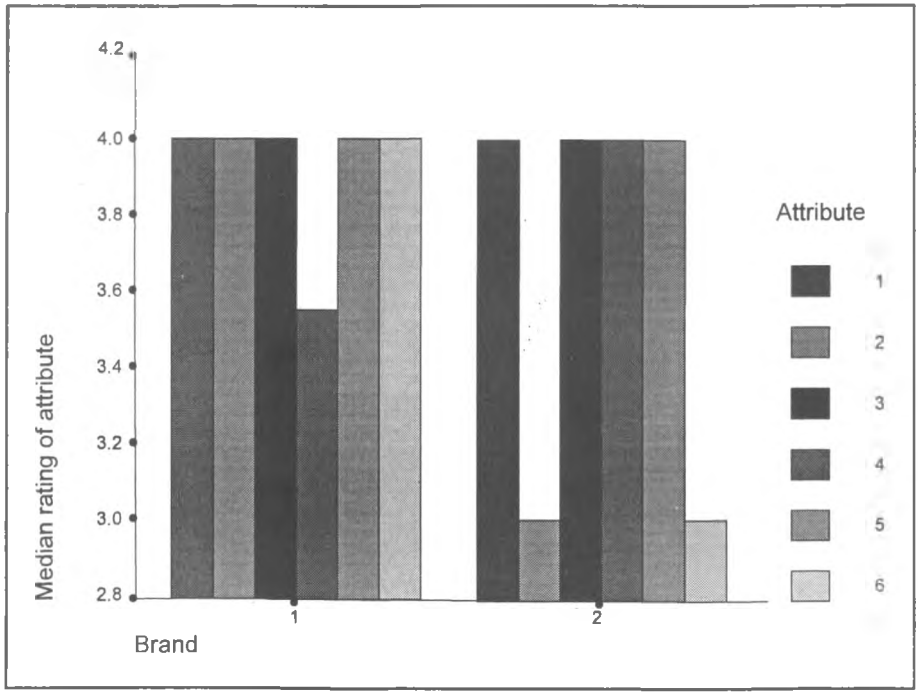

Figure 4: Median rating of each attribute by brand.

Attribute	Rating
1 – colour	1 – very bad
2 – texture	2 – bad
3 – taste	3 – average
4 – shape	4 – good
5 – size	5 – very good
6 – smell	

respondents preferring it while brands two and three each had approximately 6.5 percent of the respondents choosing them as favourites.

Figure 3 shows the median rating of each attribute for each brand. The attributes for brand five all ranked high with colour being out-standing. Some respondents felt that the slices of brand 5 were too big. The taste of brand one ranked the lowest for all attributes while for brand two colour ranked the lowest. According to the respondents the colour gave the impression that the slices were decaying. For brand three the shape of the product ranked the lowest for all attributes. Respondents indicated that the slices of brand three were too small although the brand was reported to have a good smell.

Pears

There were two brands of pears in the survey, one from Zimbabwe and the other from South Africa. Brand one from South Africa had approximately 77 percent of the respondents choosing it as their favourite. Figure 4 gives the ratings of the attributes of the two brands. The texture and smell of brand two were below average while the shape of brand one was just average. The other attributes were reported to be good. The respondents thought the slices of brand two were too big while those of brand one were too small. There was the general opinion that the pears looked like they were baked and were too sweet and sticky. The most important attribute in determining consumer preference was colour, followed by taste, smell and size respectively.

Discussion

Most vegetables were sold fresh rather than dried. This could be because the current technology is not suitable for drying, in addition to there being a limitation in the know-how regarding processing. Another reason could be that some of the vegetables are only utilised in their fresh state, for example lettuce (Chavarika, personal communication). Low density residential area shops had more dried products than the medium and high density area shops. This probably points to the high costs of dried products and reflects on the differences in income among the inhabitants of the different residential areas. The distribution of products in the CBD closely followed that in the low density areas except that there were no dried vegetables in the CBD. This suggests that the CBD shops were patronised by customers in the same income bracket as those in the low density areas.

The relationship between the distribution of dried fruits and vegetables and the socio-economic status of the inhabitants of the respective residential areas was illustrated by the distribution of products in the same retail shops belonging to OK and TM supermarkets across the different residential areas.

Zimbabwe had fewer dried products per producer on the market, possibly because commercial fruit and vegetable drying is relatively new in Zimbabwe. It

can be hypothesised that producers were stocking low quantities of produce to study consumer response to the new products. The large number of producers (or brands of products) from Zimbabwe could be because of the popularity that food processing is gaining.

For all fruits, colour was considered to be the most important attribute in determining consumer preference. It is, therefore, crucial to ensure that the colour of the product is appealing as it gives the first impression to the consumer, determining whether or not the product will be bought. Colour quality control varies with the different fruits. For some fruits it is determined when they are picked for processing (an example is of mangoes). Mangoes for processing should not be under or over ripe. Under ripe fruits give products that look papery and unattractive in addition to being prone to browning, giving a product with patches of brown colour. Over ripe fruits tend to give brown products. This is due to the presence of high levels of waste products such as carbon. The fresh products should be harvested at the appropriate stage of ripeness where they are firm enough to withstand harvesting and processing without bruising or breakage of the skin. Bruising or breakage of the skin stimulates the production of enzymes which cause browning (McBean *et al.*, 1971).

For some fruits, colour is controlled during the peeling and slicing of the fresh fruit. An example of this is of apples where browning is a result of enzyme catalysed oxidative reactions of polyphenolase on naturally occurring substances. For these, browning can be prevented by soaking the sliced fresh fruit in citric acid, lemon or lime juice for about five to 10 minutes as soon as the fresh fruit is sliced (Fellows, 1997b). Colour may also be maintained by the addition of preservatives during the actual drying process. It can also be controlled at the packaging stage where the dried fruits are packaged according to colour.

Peeling fruits also adds appeal as revealed by the negative response to brand two for apples which had not been peeled and still had seeds. Peeling also assists the drying process in that it removes the heavy layer of wax on the surface of the fruit, which if left in place would retard moisture transfer (McBean *et al.*, 1971).

The most important aspect of a product is its appearance as this determines whether or not it will be bought. Consistency in the shape and size of the product adds to the appearance of the product or product appeal. This starts at the harvesting stage where fruits are picked according to variety, which was illustrated by the responses for brand two for mangoes from small-scale producers. It was reported to have small and thin slices; a consequence of the variety of mangoes produced and processed. For this brand the size could also be because of the technology used for drying: mangoes are solar dried therefore bigger slices would take longer to dry.

The shape and the size of the product are also controlled during the slicing stage where it is important to ensure the fruits are sliced to one shape and size. The final stage of ensuring consistency is the packaging stage where fruits are packaged

according to shape and size after selecting for colour. The shape of the fruit should as far as possible bear resemblance to the original fruit. This was revealed by some of the responses for mangoes where brand one slices were said to look like fresh chips or tobacco leaves. Respondents thought it was unappealing.

The linkage between shape and size was demonstrated for pears and peaches where the products were said to be too big. The producers had, however, cut the fruits in half in an effort to maintain the shape of the fruit. To reduce the size of the product producers can cut the fruits in rings or choose smaller fruits for processing. In such cases it is important to determine the preference for the target market so that the producer makes a choice between maintaining the shape of the fruit and producing big slices or reducing the size and compromising on the shape.

In addition to appearance the product should also taste good. Controlling the taste of the product starts at the harvesting stage where fruits for processing should have reached the appropriate stage of ripeness. A balance has to be struck between the requirements for the taste and the colour. Fruits that are in advanced stages of ripening taste better than those that are not as ripe. However, fruits that are very ripe may present problems where they turn brown giving an unattractive product as discussed earlier. Fruits should be harvested when they are ripe and still firm enough to withstand processing without browning. This is important especially for mangoes. Ripeness also determines taste in that fully ripe fruits have the best taste and flavour as volatile compounds would have spread throughout the fruit (McBean *et al.*, 1971). These volatile compounds gradually decrease during the drying process thus affecting taste, while some impart a different flavour to the product as a result of chemical reactions (McBean *et al.*, 1971). Taste is also affected by the ripeness of the fruits. The level of ripeness determines the level of sugars in the fruit. As ripening takes place, starch is converted to sugars resulting in the sugar:acid ratio increasing. For the best taste this ratio should be high. However, if too high, the product may be too sweet as drying concentrates the sugars in the fruits. Producers should, therefore determine the brix content, a measure of the total soluble solids (sugar content), at which it is best to harvest the fruit. The content should then be correlated to a physiological growth stage at which producers can harvest fruits. Under ripe fruits do not have adequate levels of sugars and have high acid levels, which cause sourness (UNIFEM, 1988) as reported for brand two of the mangoes, as well as the samples of peaches. Peaches are generally acidic especially when not fully ripe, underlining the need for harvesting ripe fruits.

The management of the drying process also determines the taste of the product as was revealed by responses from the apple fruits where brand one was said to taste like a fermented product. A crucial aspect of drying is to ensure that more water is quickly driven out of the fruit at the start of the drying process than remains. The reduction of the water content slows down the rate of biochemical activities such as catabolism. Catabolism is a degradative respirational process

where, under low oxygen conditions, ethanol is released as a by-product (Wills *et al.*, 1998) giving the undesirable fermented taste. Drying should, therefore, be carried out when there is a full sun shining or with the aid of an electric dryer. This is important for all fruits, not just apples. Fruits should not be over dried as this also affects the taste. An example is brand two for mangoes where the product was indicated to be too dry and papery. The respondents indicated that the taste of the product made it difficult for them to appreciate that they were eating mangoes. Processors need to determine the moisture level at which taste is not distorted. At this moisture level the appropriate texture should be maintained while ensuring that microbial growth is retarded.

The smell of some of the products was said to have been masked by the presence of preservatives (for example brand one for mangoes). Preservatives may be necessary to ensure that colour is maintained and shelf-life increased. Rather than totally excluding preservatives it is necessary to carry out work with a view to determine the appropriate preservatives to use.

Conclusions

The survey of retail shops in the Harare-Chitungwiza metropolis showed that the products on the market were mainly from Zimbabwe and South Africa with a few from unknown countries. The distribution of the products was shown to be related to the socio-economic status of the inhabitants of the residential areas. There were more dried products in residential area shops inhabited by high-income earners while the high density areas with low income earners had no dried products at all. Dried products commanded more income per unit weight than fresh products.

For all fruits that were sampled, namely apples, mangoes, peaches and pears; colour was considered the most important attribute followed by taste and smell, respectively. While shape and size were not considered to be of equal importance to colour, respondents thought that shape and size contributed to the appearance of the product.

The management strategies discussed above are likely to achieve little without the appropriate technology. Engineers should take up the challenge and assist in developing appropriate technology for small-scale fruit and vegetable drying.

ACKNOWLEDGMENTS

The authors would like to thank Misses M. Machingambi, S. Marimbe, L. Rubaba and Mr W. Mupandawana for the assistance rendered in administering the questionnaires. We also wish to thank Mr C. Chimedza and Dr P. Chareka from the University of Zimbabwe's Statistics Department for assisting in data analysis. Last, but not least, we thank the Netherlands Organisation for International Cooperation in Higher Education (NUFFIC) for providing the financial assistance that made the study possible.

REFERENCES

DAUTHY, M. E. 1995 Fruit and vegetable processing. FAO Agricultural Services Bulletin No 119. Rome.

GOVERNMENT OF ZIMBABWE 1995 Second Five-Year National Development Plan (1991-1995). Republic of Zimbabwe, Government Printer, Harare.

FELLOWS, P. 1997a. Guidelines for small-scale fruit and vegetable processors. FAO Agricultural Services Bulletin 127. Midway Technology Ltd, Hereford, United Kingdom.

FELLOWS, P. (ed.) 1997b Traditional foods: processing for profit. Intermediate Technology Publications. London, United Kingdom.

MANZUNGU, E., MACHINGAMBI M. AND MACHIRIDZA R. 2000 An evaluation of small-scale fruit and vegetable drying in Murewa: a report prepared for Ranche House College. Harare.

MCBEAN, D. MCG., JOSLYN, M. A. AND NURY, F. S. 1971 Dehydrated fruit. In: The biochemistry of fruits and their products. A. C. Hulme (ed). Volume 2. ARC Food Research Institute, Norwich, England.

MICRO/SMALL-SCALE FOOD PROCESSING TRAINING AND DEVELOPMENT (MSFPTD) PROJECT 1994 Title of project 1. Ranche House College, Harare, Zimbabwe.

SIBANDA, A. 1996 Report on the market study for dried vegetables. Prepared for Ranche House College. Harare.

UNIFEM, 1988 Fruit and vegetable processing: food cycle technology source book *No. 2*. The United Nations Development Fund For Women. Project GLO/85/WO2 – Women and Food cycle Technology (WAFT) and Project RAF/86/WO3– Translation and Publication of Food Cycle Technology Source Books.

WILLS, R., MCGLASSON, B., GRAHAM, D. AND JOYCE, D. 1998 Post harvest: an introduction to the physiology and handling of fruits, vegetables and ornamentals 4th edition. CAB International.

ZIMBABWE INVESTMENT CENTRE 1997 Foodstuffs manufacturing Sector Studies June 1997 Troparg Consultancy Services (Pvt) Ltd.